

# 2013



## Traditional Pathway Algebra 2 Connections to Quality Core Objectives, v. 1.3

**Kentucky Department of Education**

**09/17/2013**

This sample course overview begins with the Kentucky Core Academic Standards for Mathematics (KCASM) and incorporates the assessed QualityCore (QC) objectives for Algebra 2 End of Course.

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Chart for changes to <i>KCAS Traditional Pathway Algebra 2 connections to QualityCore objectives</i>		
Version	1.1 (July 2011) to 1.2 (October 2011)	
Page #	Changes made	Notes
Page 1	Language revised to make clearer the purpose of this document and the instructions on how to use this document. The subtitle “Appendix Y” was removed as this is not a curriculum appendix document.	Revised for clarity. This document is a sample course overview connecting KCASM to the QualityCore objectives for Algebra 2 End of Course. It highlights the possible gaps as well as the connections.
Page 5,9,11,17	The border of these GAP tables is different and the middle title “gaps” has now been put into all caps.	Revised to indicate a difference in the types of table used in this document.
Throughout document		Notes and additional QC objectives added for clarity and to strengthen support for teachers.
Page 16	Translate between the geometric description and the equation for a conic section G.GPE.3 (+) Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant. QC E.3.a	Translate between the geometric description and the equation for a conic section
	1.2 to 1.3 (September 2013)	
Page 5	Language added to reflect additions	Matrices and special right triangles
Page 8, 9, 10, 12, 17	Notes added for clarity	N.CN.4 (+), N.CN.8 (+), G.SRT.11 (+), F.BF.4b-d
Page 13	Special right triangles added	F.TF.3 (+)
Page 22	Section Added to Document	Addition of Matrices to this document, due to change in the QualityCore EOC Algebra 2 blueprint and communications provided to Kentucky’s teachers.



# Kentucky Traditional Pathway Algebra 2 Connections to QualityCore Objectives

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# Kentucky Traditional Pathway Algebra 2 Connections to QualityCore Objectives

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## Introduction

After adopting the Common Core State Standards for Mathematics (CCSSM) into the Kentucky Core Academic Standards (KCASM) it was clear to educators across the Commonwealth that there would be gaps in what incoming Algebra 2 students would have been taught, according to the Program of Studies, and what the CCSSM/KCASM expected students to know and be able to do. School year time constraints, gaps in expected knowledge, and the amount of new Algebra 2 standards, relative to the Program of Studies, expected to be taught have led educators to make critical decisions about which standards to focus on from previous grades/courses and which Algebra 2 standards to deemphasize, so as to position students in the best educational position possible during this transition period.

Additionally, the changes in statewide assessment, called for in Kentucky's Senate Bill 1 2009, have placed the state in an assessment transition period. In lieu of an End of Course assessment that directly and explicitly assesses the CCSSM/KCASM, the QualityCore End of Course assessment was selected in the spring 2011 as the best available choice for the Commonwealth.

This document suggests a pathway Kentucky schools and districts could follow in order to address gap year issues and to prepare algebra 2 students for the QualityCore End of Course exam." In the column titled "KCASM Connections to QualityCore" are listed QualityCore objectives that can be explored within the context of the corresponding KCASM standard/ cluster. Moreover, this document shows which CCSSM/KCASM could be deemphasized during this transition period; KCASM that have no connections, or very weak connections, to QualityCore objectives can be identified by the lack of any information listed in the third column of the tables below.

There are a few standards measured by the QualityCore End of Course assessment that are not explicitly present in CCSSM/KCASM, because the QualityCore End of Course assessment was not designed to measure the CCSSM/KCASM; those QualityCore objectives are included within this document and marked accordingly. For instance, QualityCore objectives that include special right triangles and matrices have been added to this document. Furthermore, there are some QualityCore course objectives that are not included in the QualityCore Algebra 2 End of Course Test Blueprint. QualityCore course objectives that are not measured or reported by the End of Course assessment are not included in this document.

CCSSM Appendix A included an Overview and list of Critical Areas for Algebra 2, which is included within *this document*, in order to show which mathematics the CCSSM authors meant for Algebra 2 teachers to emphasize. Given that the objective of *this document* is to address gaps and prepare student for the QualityCore End of Course assessment, *this document* does not emphasize the same Critical Areas as the CCSSM Appendix A.

### CCSSM Appendix A: Traditional Pathway Algebra II Overview and Critical Areas

Building on their work with linear, quadratic, and exponential functions, students extend their repertoire of functions to include polynomial, rational, and radical functions.<sup>2</sup> Students work closely with the expressions that define the functions, and continue to expand and hone their abilities to model situations and to solve equations, including solving quadratic equations over the set of complex numbers and solving exponential equations using the properties of logarithms. The Mathematical Practice Standards apply throughout each course and, together with the content standards, prescribe that students experience mathematics as a coherent, useful, and logical subject that makes use of their ability to make sense of problem situations. The critical areas for this course, organized into four units, are as follows:

**Critical Area 1:** This unit develops the structural similarities between the system of polynomials and the system of integers. Students draw on analogies between polynomial arithmetic and base-ten computation, focusing on properties of operations, particularly the distributive property. Students connect multiplication of polynomials with multiplication of multi-digit integers, and division of polynomials with long division of integers. Students identify zeros of polynomials, including complex zeros of quadratic polynomials, and make connections between zeros of polynomials and solutions of polynomial equations. The unit culminates with the fundamental theorem of algebra. A central theme of this unit is that the arithmetic of rational expressions is governed by the same rules as the arithmetic of rational numbers.

**Critical Area 2:** Building on their previous work with functions, and on their work with trigonometric ratios and circles in Geometry, students now use the coordinate plane to extend trigonometry to model periodic phenomena.

**Critical Area 3:** In this unit students synthesize and generalize what they have learned about a variety of function families. They extend their work with exponential functions to include solving exponential equations with logarithms. They explore the effects of transformations on graphs of diverse functions, including functions arising in an application, in order to abstract the general principle that transformations on a graph always have the same effect regardless of the type of the underlying function. They identify appropriate types of functions to model a situation, they adjust parameters to improve the model, and they compare models by analyzing appropriateness of fit and making judgments about the domain over which a model is a good fit. The description of modeling as *“the process of choosing and using mathematics and statistics to analyze empirical situations, to understand them better, and to make decisions”* is at the heart of this unit. The narrative discussion and diagram of the modeling cycle should be considered when knowledge of functions, statistics, and geometry is applied in a modeling context.

**Critical Area 4:** In this unit, students see how the visual displays and summary statistics they learned in earlier grades relate to different types of data and to probability distributions. They identify different ways of collecting data—including sample surveys, experiments, and simulations—and the role that randomness and careful design play in the conclusions that can be drawn.

# Kentucky Traditional Pathway Algebra 2 Connections to QualityCore Objectives

## Unit 1: Polynomial, Rational and Radical Relations

This unit develops the structural similarities between the system of polynomials and the system of integers. Students draw on analogies between polynomial arithmetic and base-ten computation, focusing on properties of operations, particularly the distributive property. Students connect multiplication of polynomials with multiplication of multi-digit integers, and division of polynomials with long division of integers. Students identify zeros of polynomials, including complex zeros of quadratic polynomials, and make connections between zeros of polynomials and solutions of polynomial equations. The unit culminates with the fundamental theorem of algebra. Rational numbers extend the arithmetic of integers by allowing division by all numbers except 0. Similarly, rational expressions extend the arithmetic of polynomials by allowing division by all polynomials except the zero polynomial. A central theme of this unit is that the arithmetic of rational expressions is governed by the same rules as the arithmetic of rational numbers.

## Unit 1: Possible GAPS between KCAS Clusters and Standards Connections to QualityCore Objectives

Clusters	Possible GAPS (CCSSM/ KCASM content that may not have been previously taught)	KCAS Connection to QualityCore Objectives
Extend the properties of exponents to rational exponents.	N.RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.	G.1.b, G.1.c, G.1.f, G.1.d, G.1.e
Understand the concept of a function and use function notation	F.IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.	H.2.a, H.2.b, H.2.d (F.IF.2 does not explicitly state to find the position of a given term, although this relationship and procedure are likely to naturally arise when addressing this KCASM. The inverse relationships are further explored by F.BF.4 in unit 3 of this appendix – including (+) standards.
Understand the concept of a function and use function notation	F.IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by $f(0) = f(1) = 1$ , $f(n + 1) = f(n) + f(n - 1)$ for $n > 1$ .	H.2.a, H.2.b (see note above regarding this QC standard)



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Analyze functions using different representations.	F.IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (Modeling Standard) a. Graph linear and quadratic functions and show intercepts, maxima, and minima.	E.2.a
Build a function that models a relationship between two quantities.	F.BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms. (Modeling Standard)	H.2.a, H.2.b, H.2.d
Solve equations and inequalities in one variable.	A.REI.4b Solve quadratic equations by inspection (e.g., for $x^2 = 49$ ), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers $a$ and $b$ .	E.1.b

### Unit 1: KCASM Clusters and Standards Connections to QualityCore Objectives

KCASM Clusters	KCASM/CCSSM Appendix A: Algebra 2	KCASM connections to QualityCore Objectives
Perform arithmetic operations with complex numbers	N.CN.1 Know there is a complex number $i$ such that $i^2 = -1$ , and every complex number has the form $a + bi$ with $a$ and $b$ real.	C.1.a
	N.CN.2 Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.	C.1.b
	N.CN.3 (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.	C.1.a, C.1.c
	N.CN.4 (+) Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number.	Not explicit in the QualityCore objectives
	N.CN.5 (+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. For example, $(-1 + \sqrt{3}i)^3 = 8$ because $(-1 + \sqrt{3}i)$ has modulus 2 and argument $120^\circ$ .	C.1.b, C.1.c (in context this could extend to N.CN.6 (+))
Use complex numbers in	N.CN.7 Solve quadratic equations with real coefficients that have complex	E.1.c

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polynomial identities and equations.	solutions	
	N.CN.8 (+) Extend polynomial identities to the complex numbers. <i>For example, rewrite <math>x^2 + 4</math> as <math>(x + 2i)(x - 2i)</math>.</i>	Not explicit but related to N.CN.3 (+) which connects to C.1.c and C.1.d
	N.CN.9 (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.	
Interpret the structure of expressions.	A.SSE.1 Interpret expressions that represent a quantity in terms of its context. (Modeling standard) a. Interpret parts of an expression, such as terms, factors, and coefficients. b. Interpret complicated expressions by viewing one or more of their parts as a single entity. <i>For example, interpret <math>P(1+r)^n</math> as the product of <math>P</math> and a factor not depending on <math>P</math>.</i>	A.SSE.1a and A.SSE.1b undergird many standards within the assessed QC conceptual areas, including, but not limited to: F.1.a, F.1.b, G.1.c
	A.SSE.2 Use the structure of an expression to identify ways to rewrite it. <i>For example, see <math>x^4 - y^4</math> as <math>(x^2)^2 - (y^2)^2</math>, thus recognizing it as a difference of squares that can be factored as <math>(x^2 - y^2)(x^2 + y^2)</math>.</i>	A.SSE.2 undergirds many standards within the assessed QC conceptual areas, including but not limited to: C.1.b, C.1.c, F.1.a, F.1.b, G.1.c, G.1.e
Write expressions in equivalent forms to solve problems.	A.SSE.4 Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. <i>For example, calculate mortgage payments.</i> (Modeling standard)	F.1.a, H.2.c, H.2.d, H.2.e (these KCASM do not address finding the sum of an arithmetic series, exploration and derivation of the sum of an arithmetic series could occur in connection to a variety of standards, including an application of SMP 8)
Perform arithmetic operations on polynomials.	A.APR.1 Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.	F.1.a, F.1.b
Understand the relationship between zeros and factors of polynomials.	A.APR.2 Know and apply the Remainder Theorem: For a polynomial $p(x)$ and a number $a$ , the remainder on division by $x - a$ is $p(a)$ , so $p(a) = 0$ if and only if $(x - a)$ is a factor of $p(x)$ .	F.1.a, F.1.b, F.2.a, F.2.b, F.2.c
	A.APR.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.	F.1.b, F.2.a, F.2.b, F.2.c, F.2.d
Use polynomial identities to solve problems.	A.APR.4 Prove polynomial identities and use them to describe numerical relationships. <i>For example, the polynomial identity <math>(x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2</math> can be used to generate Pythagorean triples.</i>	(A component of this KCASM can be addressed through F.1.a, although the “proof” component is

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		not addressed by any QC objectives.)
	A.APR.5 (+) Know and apply the Binomial Theorem for the expansion of $(x + y)^n$ in powers of $x$ and $y$ for a positive integer $n$ , where $x$ and $y$ are any numbers, with coefficients determined for example by Pascal's Triangle.	F.1.a
Rewrite rational expressions	A.APR.6 Rewrite simple rational expressions in different forms; write $a(x) / b(x)$ in the form $q(x) + r(x) / b(x)$ , where $a(x)$ , $b(x)$ , $q(x)$ , and $r(x)$ are polynomials with the degree of $r(x)$ less than the degree of $b(x)$ , using inspection, long division, or, for the more complicated examples, a computer algebra system.	F.1.b, G.1.e
	A.APR.7 (+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.	G.1.a, G.1.e
Understand solving equations as a process of reasoning and explain the reasoning. Represent and solve equations and inequalities graphically.	A.REI.2 Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.	G.1.a, G.1.b, G.1.c, G.1.d, G.1.e, G.1.f, G.1.g
	A.REI.11 Explain why the $x$ -coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$ ; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.	E.1.d, F.2.a, F.2.b, F.2.d, (This KCASM connects to QC F.2.a, b, and d objectives if function $f(x)$ or $g(x)$ are defined as the zero polynomial) G.1.f, (A.REI.11 is an underpinning standard for QC D.2.a and E.2.c.)
Analyze functions using different representations.	F.IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.	F.2.c, F.2.d

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### Unit 2: Trigonometric Functions

Building on their previous work with functions, and on their work with trigonometric ratios and circles in Geometry, students now use the coordinate plane to extend trigonometry to model periodic phenomena.

#### Unit 2: Possible GAPS between KCAS Clusters and Standards Connections to QualityCore Objectives

Clusters	Possible GAPS (CCSSM/ KCASM content that may not have been previously taught)	KCAS Connection to QualityCore Objectives
Define trigonometric ratios and solve problems involving right triangles	G.SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems (modeling standard).	A.1.i
Apply trigonometry to general triangles	G.SRT.11. (+) Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g. surveying problems, resultant forces).	G.3.a (Students are not required to prove the Law of Sines and Law of Cosines)
Find arc lengths and areas of sectors of circles	G.C.5. Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.	G.3.c
Translate between the geometric description and the equation for a conic section	G.GPE.1 Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.	E.3.a, E.3.c (E.3.b and E.3.d, respectively, concern graphing circles, and, writing equations from graphs, and are not explicitly dealt with by this KCASM standard; however, this standard can easily be extended to include E.3.b and E.3.d)

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### Unit 2: KCAS Clusters and Standards Connections to QualityCore Objectives

Clusters	Kentucky Core Academic Standards (CCSSM Alg 2 Appendix A)	KCAS Connections to QualityCore
Extend the domain of trigonometric functions using the unit circle.	<p>F.TF.1 Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.</p> <p>F.TF.2 Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.</p> <p>F.TF.3 (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for <math>\pi/3</math>, <math>\pi/4</math> and <math>\pi/6</math>, and use the unit circle to express the values of sine, cosine, and tangent for <math>x</math>, <math>\pi + x</math>, and <math>2\pi - x</math> in terms of their values for <math>x</math>, where <math>x</math> is any real number.</p>	G.3.b, G.3.c, G.3.g (While this standard does not make an explicit connection to degree measurement, there is a progression from KCASM G.C.5 towards F.TF.5 that this connection would strengthen, and then clearly connect to G.3.c).
Model periodic phenomena with trigonometric functions.	F.TF.5 Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.	G.3.c, G.3.d, G.3.g
Prove and apply trigonometric identities.	F.TF.8 Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find $\sin(\theta)$ , $\cos(\theta)$ , or $\tan(\theta)$ , given $\sin(\theta)$ , $\cos(\theta)$ , or $\tan(\theta)$ , and the quadrant of the angle.	

## Unit 3: Modeling with Functions

In this unit students synthesize and generalize what they have learned about a variety of function families. They extend their work with exponential functions to include solving exponential equations with logarithms. They explore the effects of transformations on graphs of diverse functions, including functions arising in an application, in order to abstract the general principle that transformations on a graph always have the same effect regardless of the type of the underlying function. They identify appropriate types of functions to model a situation, they adjust parameters to improve the model, and they compare models by analyzing appropriateness of fit and making judgments about the domain over which a model is a good fit. *The description of modeling as “the process of choosing and using mathematics and statistics to analyze empirical situations, to understand them better, and to make decisions” is at the heart of this unit. The narrative discussion and diagram of the modeling cycle should be considered when knowledge of functions, statistics, and geometry is applied in a modeling context.*

### Unit 3: Possible GAPS between KCAS Clusters and Standards Connections to QualityCore Objectives

Clusters	Possible GAPS (CCSSM/ KCASM content that may not have been previously taught)	KCAS Connections to QualityCore Objectives
Solve equations and inequalities in one variable	<p>A.REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</p> <p>A.REI.4 Solve quadratic equations in one variable.</p> <p>a. Use the method of completing the square to transform any quadratic equation in <math>x</math> into an equation of the form <math>(x - p)^2 = q</math> that has the same solutions. Derive the quadratic formula from this form.</p> <p>A.REI.4 Solve quadratic equations in one variable.</p> <p>b. Solve quadratic equations by inspection (e.g., for <math>x^2 = 49</math>), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as <math>a \pm bi</math> for real numbers <math>a</math> and <math>b</math>.</p>	<p>A.1.d, D.1.a (include absolute value functions), D.1.b</p> <p>E.1.a (Solving quadratic inequalities is addressed by A.CED.1)</p> <p>E.1.a (While using the discriminant to determine the number and type of roots is not explicitly addressed, use of the quadratic formula will easily extend to the use of the discriminant.), G.1.c</p>
Solve systems of equations	<p>A.REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.</p> <p>A.REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.</p>	<p>A.1.e</p> <p>A.1.e, D.1.c (systems containing three variables should also be explored)</p>

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Apply geometric concepts in modeling situations	G.MG.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder). (Modeling standard) G.MG.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios). (Modeling standard)	E.3.b, E.3.d (these two QC standards can be addressed by these two KCASM standards).
Represent and solve equations and inequalities graphically	A.REI.12 Graph the solutions to a linear inequality in two variables as a halfplane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.	D.2.a, D.2.b (KCASM/ CCSSM A.REI.12 doesn't explicitly mention "finding maximum and minimum values of a function over a region defined by linear inequalities" as does QC D.2.b)
Analyze functions using different representations	F.IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (Modeling standard) a. Graph linear and quadratic functions and show intercepts, maxima, and minima.	E.3.b (this standards does not address the "circle" component of E.3.b), F.2.c
	F.IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.	E.3.c
Construct and compare linear, quadratic, and exponential models and solve problems	F.LE.4 For exponential models, express as a logarithm the solution to $ab^{ct} = d$ where $a$ , $c$ , and $d$ are numbers and the base $b$ is 2, 10, or $e$ ; evaluate the logarithm using technology. (Modeling domain)	G.2.b
Translate between the geometric description and the equation for a conic section	G.GPE.1 Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.	E.3.a, E.3.b E.3.c, E.3.d (while G.GPE.1 doesn't explicitly address graphing, it is implied by the CCSSM/ KCASM)
	G.GPE.2 Derive the equation of a parabola given a focus and directrix.	E.3.a, E.3.b, E.3.c, E.3.d



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## Unit 3: KCAS Clusters and Standards Connections to QualityCore Objectives

Clusters	KCASM/CCSSM Appendix A: Algebra 2	KCAS Connections to QualityCore Objectives
Create equations that describe numbers or relationships.	A.CED.1 Create equations and inequalities in one variable and use them to solve problems. <i>Include equations arising from linear and quadratic functions, and simple rational and exponential functions.</i> (Modeling domain)	E.1.a, G.3.g, H.2.d, H.2.e (e.g. for $h(i) = i - 2$ , $\sum_{i=2}^4 h(i) = (2-2) + (3-2) + (4-2)$ )
	A.CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (Modeling domain)	
	A.CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. <i>For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.</i> (Modeling domain)	D.1.b, D.1.c, D.2.a, E.1.d, E.2.c, G.3.g
	A.CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. <i>For example, rearrange Ohm's law <math>V = IR</math> to highlight resistance <math>R</math>.</i> (Modeling domain)	This KCASM standard undergirds many standards within the assessed QC conceptual areas, including, but not limited to: F.1.a, G.1.a, G.1.g
Translate between the geometric description and the equation for a conic section	<b>G.GPE.3 (+) Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.</b>	E.3.a
Interpret functions that arise in applications in terms of a context.	F.IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. <i>Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.</i> (Modeling standard)	G.3.e, G.3.f, G.3.g
	F.IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. <i>For example, if the function <math>h(n)</math> gives the number of person-hours it takes to</i>	C.1.d, E.2.a, F.2.d, G.3.e (these QC standards concern the determination of range, although



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	<i>assemble <math>n</math> engines in a factory, then the positive integers would be an appropriate domain for the function.</i>	F.IF.5 does not explicitly do so; range can be addressed by F.IF.4 or F.IF.5)
	F.IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph. (Modeling standard)	
Analyze functions using different representations.	F.IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (Modeling standard) b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.	E.2.b, F.2.b
	F.IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (Modeling standard) e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.	E.2.b, G.2.a, G.3.d, G.3.e, G.3.f
	F.IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.	This KCASM standard undergirds many standards within the assessed QC conceptual areas, including, but not limited to: E.1.a, F.1.b, G.1.b, G.1.c, G.1.e
	F.IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.	
Build a function that models a relationship between two quantities.	F.BF.1 Write a function that describes a relationship between two quantities. (Modeling standard) b. Combine standard function types using arithmetic operations. <i>For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.</i>	C.1.d, E.2.a (Determination of the domain and range of combined functions are not explicitly addressed by F.BF.1, but can be addressed by extending understanding from F.IF.5)
	F.BF.1 Write a function that describes a relationship between two quantities. c. (+) Compose functions. <i>For example, if <math>T(y)</math> is the temperature in the atmosphere as a function of height, and <math>h(t)</math> is the height of a weather balloon as a function of time, then <math>(h(t))</math> is the temperature at the location of the weather balloon as a function of time.</i>	This KCASM is not included in Appendix A for Alg 2, but is included here to address the function composition component of C.1.d. F.BF4b-d(+) is an extension of this objective.

## Kentucky Traditional Pathway Algebra 2 Connections to QualityCore Objectives

Build new functions from existing functions.	F.BF.3 Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$ , $k f(x)$ , $f(kx)$ , and $f(x + k)$ for specific values of $k$ (both positive and negative); find the value of $k$ given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.	E.2.b, E.3.b (this QC standard only requires studying translations on circles and parabolas)
	F.BF.4 Find inverse functions. a. Solve an equation of the form $f(x) = c$ for a simple function $f$ that has an inverse and write an expression for the inverse. <i>For example, <math>f(x) = 2x^3</math> or <math>f(x) = (x+1)/(x-1)</math> for <math>x \neq 1</math>.</i>	This KCASM standard undergirds many standards within the assessed QC conceptual areas, including: G.2.b, H.2.b, H.2.d
	F.BF.5 (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.	This KCASM is not included in Appendix A for Alg 2, but is included here to address multiple QC standards, including but not limited to: G.1.c, G.1.f, G.2.b
Construct and compare linear, quadratic, and exponential models and solve problems.	F.LE.4 For exponential models, express as a logarithm the solution to $ab^{ct} = d$ where $a$ , $c$ , and $d$ are numbers and the base $b$ is 2, 10, or $e$ ; evaluate the logarithm using technology. (Modeling domain)	G.2.b

## Unit 4: Inferences and Conclusions from Data

In this unit, students see how the visual displays and summary statistics they learned in earlier grades relate to different types of data and to probability distributions. They identify different ways of collecting data—including sample surveys, experiments, and simulations—and the role that randomness and careful design play in the conclusions that can be drawn.

### Unit 4: Possible GAPS between KCAS Clusters and Standards Connections to QualityCore Objectives

Clusters	Possible GAPS (CCSSM/ KCASM content that may not have been previously taught)	KCAS Connections to QualityCore Objectives
Investigate chance processes and develop, use, and evaluate probability models.	<p>7.SP.8 Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation.</p> <p>a. Understand that, just as with simple events, the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs.</p> <p>b. Represent sample spaces for compound events using methods such as organized lists, tables and tree diagrams. For an event described in everyday language (e.g., “rolling double sixes”), identify the outcomes in the sample space which compose the event.</p> <p>c. Design and use a simulation to generate frequencies for compound events. <i>For example, use random digits as a simulation tool to approximate the answer to the question: If 40% of donors have type A blood, what is the probability that it will take at least 4 donors to find one with type A blood?</i></p>	H.1.a
Understand independence and conditional probability and use them to interpret data	S.CP.1 Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events (“or,” “and,” “not”).	H.1.e
	S.CP.2 Understand that two events $A$ and $B$ are independent if the probability of $A$ and $B$ occurring together is the product of their probabilities, and use this characterization to determine if they are	H.1.c, H.1.d

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	independent.	
	S.CP.3 Understand the conditional probability of $A$ given $B$ as $P(A \text{ and } B) / P(B)$ , and interpret independence of $A$ and $B$ as saying that the conditional probability of $A$ given $B$ is the same as the probability of $A$ , and the conditional probability of $B$ given $A$ is the same as the probability of $B$ .	H.1.c, H.1.d, H.1.f
Use the rules of probability to compute probabilities of compound events in a uniform probability model	S.CP.6 Find the conditional probability of $A$ given $B$ as the fraction of $B$ 's outcomes that also belong to $A$ , and interpret the answer in terms of the model.	H.1.c, H.1.d, H.1.e, H.1.f
	S.CP.7 Apply the Addition Rule, $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$ , and interpret the answer in terms of the model.	H.1.c, H.1.d, H.1.e
	S.CP.8 (+) Apply the general Multiplication Rule in a uniform probability model, $P(A \text{ and } B) = P(A) P(B A) = P(B) P(A B)$ , and interpret the answer in terms of the model.	H.1.c, H.1.d, H.1.e, H.1.f
	S.CP.9 (+) Use permutations and combinations to compute probabilities of compound events and solve problems.	H.1.b

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## Unit 4: KCAS Clusters and Standards Connections to QualityCore Objectives

Clusters	KCASM/CCSSM Appendix A: Algebra 2	KCAS Connections to QualityCore Objectives
Summarize, represent, and interpret data on a single count or measurement variable.	S.ID.4 Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.	
Understand and evaluate random processes underlying statistical experiments	S.IC.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.	
	S.IC.2 Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. <i>For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?</i>	
Make inferences and justify conclusions from sample surveys, experiments, and observational studies	S.IC.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.	
	S.IC.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.	
	S.IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.	
	S.IC.6 Evaluate reports based on data.	
Use probability to evaluate outcomes of decisions.	S.MD.6 (+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).	All components of QC Section H can be applied to both of these standards
	S.MD.7 (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).	

**Additional Connections not included in Appendix A: KCAS Clusters and Standards  
Connections to QualityCore Objectives**

Clusters	KCASM/CCSSM Appendix A: Algebra 2	KCAS Connections to QualityCore Objectives
Solve systems of equations.	<p>A.REI.8 (+) Represent a system of linear equations as a single matrix equation in a vector variable.</p> <p>A.REI.9 (+) Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension <math>3 \times 3</math> or greater).</p>	I.1.c, I.1.d, I.1.e, I.1.f
Perform operations on matrices and use matrices in applications.	<p>N.VM.6 (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.</p> <p>N.VM.7 (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.</p> <p>N.VM.8 (+) Add, subtract, and multiply matrices of appropriate dimensions.</p> <p>N.VM.9 (+) Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties.</p> <p>N.VM.10 (+) Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.</p> <p>N.VM.11 (+) Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.</p> <p>N.VM.12 (+) Work with <math>2 \times 2</math> matrices as a transformations of the plane, and interpret the absolute value of the determinant in terms of area.</p>	I.1.a - f